

CLAIMS

1. A safety system for an industrial press having a moveable section, the safety system including

a laser device for emitting a plurality of parallel continuous planar beams having a generally constant lateral width;

a light receiver for receiving the planar beams and for detecting when an object intersects at least one of the planar beams; and

a controller for stopping or preventing motion of the moveable section when the receiving means detects that at least one of the planar beams has intersected an object,

said controller further adapted to decelerate the moveable section from a first speed to a second speed within a deceleration zone said zone defined between a first point at which a first planar beam passes a speed control point and a second point at which a second planar beam passes the speed control point.

2. The safety system according to claim 1 wherein the first and second planar beams are adjacent.

3. The safety system according to claim 1 or claim 2 wherein the laser device includes a plurality of laser emitters for respectively emitting a laser beam and a lens assembly for respectively converting each said laser beam emitted from a said laser emitter to a said continuous planar laser beam.

4. The safety system according to claim 3 wherein the lens assembly includes a cylindrical prism for initially expanding the or each laser beam into a planar fan-shaped laser beam and a converging lens for refocusing the fan-shaped laser beam to a planar laser beam having a generally constant lateral width.

5. The safety system according to claim 3 or 4 wherein the lens assembly is used to convert each laser beam to facilitate the correct alignment of the final planar laser beam.

6. The safety system according to claim 1 further including a plurality of laser devices used to provide the continuous planar laser beams.

7. The safety system according to any one of the preceding claims wherein peripheral edges of the plane defined by the planar laser beam extend laterally beyond opposing sides of the moveable section.

8. The safety system according to any one of the preceding claims wherein a single said light receiver is used to receive the planar beams.

9. The safety system according to any one of the preceding claims wherein the light receiver includes an array of light receiving elements, the elements being aligned along a common axis and located at an end of a receiver body of the light receiver.

10. The safety system according to any one of the preceding claims wherein a cylindrical lens is provided to focus the planar laser beams onto the light receiver array.

11. The safety system according to any one of the preceding claims wherein the planar laser beams are multiplexed such that each laser beam is sequentially turned off and on creating pulses so that the light receiver only detects one of said laser beams at one time.

12. The safety system according to claim 11 wherein the pulses are created at a pre-determined pulse rate.

13. The safety system according to any one of the preceding claims wherein the industrial press further includes a stationary section such that the laser beams are located between the moveable and stationary sections of the industrial press.

The safety system according to any one of the preceding claims wherein the moveable section includes a leading edge and each laser beam is spaced at a different distance to the leading edge.

15. The safety system according to claim 14 wherein there are two said planar laser beams emitted by the laser emitting means with a first said planar laser beam being spaced further from the leading edge than a second said planar laser beam, said first and second planar laser beams defining a single deceleration zone.

16. The safety system according to any one of the preceding claims wherein the first and second speed of the moveable section is measured at the respective first point and the second points.

17. The safety system according to claim 16 wherein the speed measurement is performed by the controller measuring the number of pulses at the pulse rate as the moveable section travels a predetermined distance.

18. The safety system according to claim 17 wherein the predetermined distance is bisected by the speed control point.

19. The safety system according to claim 18 wherein the predetermined distance is 2 mm commencing 1 mm above the speed control point and finishing 1 mm below the speed control point.

20. The safety system according to any one of claims 15 to 19 wherein the first speed is a maximum operating speed of the industrial press.

21. The safety system according to any one of claims 15 to 20 wherein the second speed is a final crawl speed.

22. The safety system according to any one of claims 15 to 21 wherein the controller decelerates the moveable section at a rate such that the speed of the

moveable section as a mid point between the first point and second point passes the speed control point is 50% of the operating speed of the industrial press.

23. The safety system according to any one of claims 20 to 22 wherein if the speed measurement detects a speed exceeding the first speed at the first point, the final crawl speed at the second point or 50% of the operating speed at the mid point, then the controller will stop the moveable section by shutting off the industrial press.

24. The safety system according to any one of the preceding claims wherein as each planar beam passes the speed control point the respective planar laser beam is muted whereby intersection of the planar beam by the object will not prevent motion of the moveable section.

25. The safety system according to claim 24 wherein the muted planar laser beam is still pulsed and speed measurement is still possible.

26. The safety system according to any one of the preceding claims wherein the speed control point is located 2 mm above a surface of material operated on by the industrial press.

27. The safety system according to any one of claims 15 to 26 wherein the first and second planar laser beams are spaced along an axis parallel to the movement of the moveable section by 10 mm.

28. The safety system according to any one of claims 15 to 27 wherein the first planar laser beam and the moveable section are spaced along an axis parallel to the movement of the moveable section by 4 mm.

29. The safety system according to any one of claims 21 to 28 wherein the final crawl speed is 20 mm per second.

The safety system according to any one of claims 15 to 29 wherein the controller further decelerates the moveable section from the second point to a third point, said third point located at which the leading edge of the moveable section passes the speed control point.

31. The safety system according to claim 30 wherein the moveable section is decelerated from 20 mm per second to 10 mm per second between the second point and the third point.

32. A safety system for an industrial press having a moveable section, the safety system including

a laser device for emitting a continuous beam of rectilinear cross-section having a generally constant lateral width and generally constant depth;

said rectilinear beam having a proximate and distal face relative to a leading edge of the moveable section;

a light receiver for receiving the rectilinear beam and for detecting when an object intersects at least a portion of the beam; and

a controller for stopping or preventing motion of the moveable section when the receiving means detects that at least a portion of the rectilinear beam has intersected an object,

said controller further adapted to decelerate the moveable section from a first speed to a second speed within a deceleration zone said zone defined between a first point at which the proximate face passes a speed control point and a second point at which the distal face passes the speed control point.

33. The safety system according to any one of the preceding claims wherein the first and second speed of the moveable section is measured at the respective first point and the second points.

34. The safety system according to claim 32 wherein the speed measurement is performed by the controller measuring the number of pulses at the pulse rate as the moveable section travels a predetermined distance.

The safety system according to claim 34 wherein the predetermined distance is bisected by the speed control point.

36. The safety system according to claim 35 wherein the predetermined distance is 2 mm commencing 1 mm above the speed control point and finishing 1 mm below the speed control point.

37. The safety system according to any one of claims 32 to 36 wherein the first speed is a maximum operating speed of the industrial press.

38. The safety system according to any one of claims 32 to 37 wherein the second speed is a final crawl speed.

39. The safety system according to any one of claims 32 to 38 wherein the controller decelerates the moveable section at a rate such that the speed of the moveable section as a mid point between the first point and second point passes the speed control point is 50% of the operating speed of the industrial press.

40. The safety system according to any one of claims 37 to 39 wherein if the speed measurement detects a speed exceeding the first speed at the first point, the final crawl speed at the second point or 50% of the operating speed at the mid point, then the controller will stop the moveable section by turning off the industrial press.

41. The safety system according to any one of the preceding claims wherein as the rectilinear beam progressively passes the speed control point the rectilinear beam is correspondingly progressively muted whereby intersection of the rectilinear beam at a muted portion of the rectilinear beam by the object will not prevent motion of the moveable section.

42. The safety system according to claim 41 wherein the muted portion of the rectilinear beam is still pulsed and speed measurement is still possible.

The safety system according to any one of the preceding claims wherein the speed control point is located 2 mm above a surface of material operated on by the industrial press.

44. The safety system according to any one of claims 32 to 43 wherein the depth of the rectilinear beam is 10 mm.

45. The safety system according to any one of claims 32 to 44 wherein the proximate face and the moveable section are spaced along an axis parallel to the movement of the moveable section by 4 mm.

46. The safety system according to any one of claims 38 to 45 wherein the final crawl speed is 20 mm per second.

47. The safety system according to any one of claims 32 to 46 wherein the controller further decelerates the moveable section from the second point to a third point, said third point located at which the leading edge of the moveable section passes the speed control point.

48. The safety system according to claim 47 wherein the moveable section is decelerated from 20 mm per second to 10 mm per second between the second point and the third point.

49. The safety system according to any one of the preceding claims wherein the laser device includes a plurality of laser emitters for respectively emitting a laser beam and a lens assembly for respectively converting each said laser beam emitted from a said laser emitter to a said continuous rectilinear laser beam.

50. The safety system according to claim 49 wherein the lens assembly includes a first cylindrical prism for initially expanding the or each laser beam into a planar fan-shaped laser beam in one plane, a first converging lens for refocusing the fan-shaped laser beam to a planar laser beam having the generally constant lateral width, a second cylindrical prism, orthogonal to the first

cylindrical prism, for expanding the planar laser beam into a prismatic fan-shaped laser beam and a second converging lens for refocusing the prismatic fan-shaped laser beam to a rectilinear laser beam having both the generally constant lateral width and the generally constant depth.

51. The safety system according to any one of the preceding claims wherein the light receiver includes a two dimensional array of light receiving elements, the elements being placed in a rectilinear distribution and located at an end of a receiver body of the light receiver.

52. The safety system according to any one of claims 32 to 51 said rectilinear beam further including a rectilinear portion of depth sufficient to span from the proximate face to a partial intersection with the leading edge of the moveable section, said rectilinear portion having the generally constant lateral width, wherein the light receiver further includes light receiving elements corresponding to the rectilinear portion, such that the light receiving elements corresponding to an area where the moveable section intersects with the rectilinear portion do not function to prevent movement of the moveable section.

53. A method for setting the safety distance between a single planar laser beam and a leading edge of a moveable section of an industrial press, the method including the steps of :

converging the planar beam along an axis parallel to the movement of the moveable section until the leading edge interrupts the planar beam;
diverging the planar beam away from the leading edge along the axis by a pre-determined distance, said pre-determined distance set as the safety distance.

54. The method according to claim 53 wherein the method is performed under automatic control

55. The method according to claim 54 further including the step of actuating the automatic control by an operator to calibrate the industrial press, said step preceding the converging step.

56. The method according to any one of claims 53 to 55 wherein the planar laser beam, associated emitters and receivers to generate and detect the beam and the controller form part of a safety system mounted to the industrial press.

57. A method of operating a safety system for an industrial press having a moveable section and a stationary section, the safety system providing a plurality of continuous planar laser beams having a generally constant lateral width, each laser beam being spaced at varying distances from the moveable section, the method including moving the moveable section towards the stationary section at a relatively high speed;

starting deceleration of the moveable section when one said laser beam reaches a speed control point located immediately adjacent the stationary section,

moving the moveable section at a final crawl speed when a second said laser beam reaches the speed control point, the moveable section continuing to move at said final crawl speed towards said stationary section.